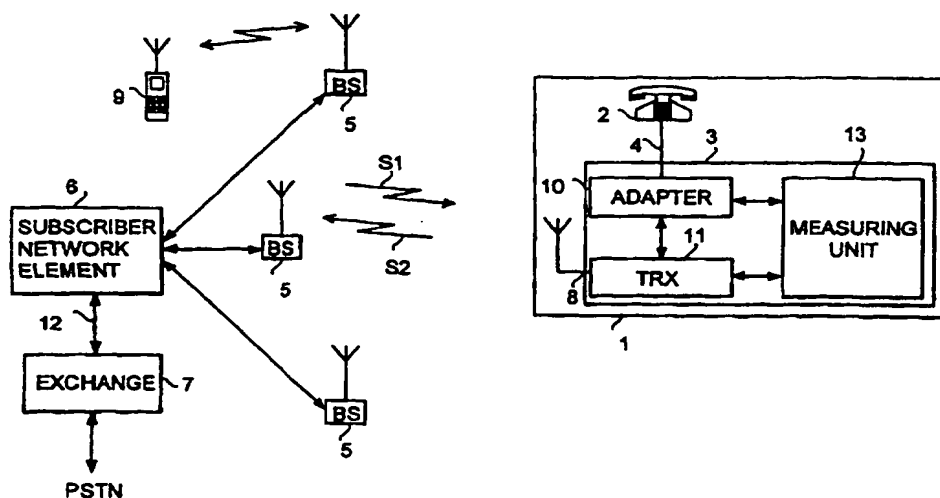




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/FI97/00151 <b>(22) International Filing Date:</b> 6 March 1997 (06.03.97) <b>(30) Priority Data:</b> 961074 7 March 1996 (07.03.96) FI <b>(71) Applicant (for all designated States except US):</b> NOKIA TELECOMMUNICATIONS OY [FI/FI]; Upseerinkatu 1, FIN-02600 Espoo (FI). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> LÄHDEMÄKI, Heimo [FI/FI]; Nuijamiehentie 18, FIN-33960 Pirkkala (FI). <b>(74) Agent:</b> KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the          claims and to be republished in the event of the receipt of          amendments.</i>

**(54) Title:** METHOD AND SYSTEM FOR TESTING THE CONDITION OF A SUBSCRIBER STATION IN A RADIO SYSTEM

**(57) Abstract**

A method of testing the condition of a subscriber station in a radio system providing a wireless subscriber interface. To allow for versatile testing of the condition of the subscriber station (1), it is equipped with testing means (13) for execution of tests indicative of the condition of the subscriber station, a predetermined testing message (S1) is transmitted via the radio path to the testing means (13) of the subscriber station when no connection is active from the subscriber station, the testing message containing information indicating the test to be carried out, and a message (S2) indicative of the results of the test carried out is received from the subscriber station (1) via the radio path.

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Method and system for testing the condition of  
a subscriber station in a radio system

The present invention relates to a method of testing the condition of a subscriber station in a radio system providing a wireless subscriber interface. The invention further relates to a radio system providing a wireless subscriber interface and comprising a subscriber network element in a data transmission connection with a local exchange of a public telephone network, a base station and subscriber stations, the subscriber network element and said base station comprising means for transfer of telecommunication signals between the local exchange and the subscriber stations. The invention further relates to a subscriber station in a radio system providing a wireless subscriber interface and consisting of terminal equipment having a radio part, and of a user interface linked to the terminal equipment by means of a two-wire line.

The invention relates to monitoring the operation of a subscriber station used in a WLL system (Wireless subscriber interface), that is, a radio system providing a wireless subscriber interface. In the WLL system, a usual two-wire telephone set is linked by means of special terminal equipment via a radio connection to a local exchange in a telephone network, the exchange in turn being linked to the public telephone network via network cabling. In this connection, a subscriber station refers to the equipment available to a subscriber for transmitting and receiving telecommunication signals, that is, in the case of the WLL system, the subscriber station comprises WLL terminal equipment consisting of a radio part and a teleadapter (to which a user interface, such as a telephone set, is connected), and a user interface, such as a telephone, a telefax terminal, a computer/modem combination or the like, connected to the terminal equipment.

For disturbance-free transfer of telecommunication signals, e.g. signals associated with a call, subscribers stations have to be monitored in the WLL system in order for possible malfunction to be detected as early as possible. Monitoring is very difficult in the WLL system as the WLL terminal is situated on subscriber premises where the operator maintenance personnel have no entry. This is why the condition of a WLL subscriber station has to be monitored via the radio path.

A method of monitoring the operation of a subscriber station in the WLL system is previously known, wherein a call is transmitted to the subscriber station, the call being selected so that the subscriber station answers it automatically. Having answered the call, the subscriber station is diagnosed to

be operative. Conversely, if the subscriber station does not answer the call, the call is repeated until the subscriber station has failed to answer a predetermined number of calls, and consequently the subscriber station is diagnosed to be inoperative.

5           The most significant weakness of the above known method is that the only information conveyed on the subscriber station is that the WLL subscriber station answers a call received via the radio path. This information is not sufficient for the operator to, e.g. by maintenance or the like, prevent disturbance, or alternatively, deal with temporary disturbances before the user of  
10   the subscriber station detects the disturbance.

          It is an object of the present invention to solve the above problem and provide a better and more versatile method of monitoring the operation of subscriber stations in order to detect possible malfunction as early as possible, even before the user of the subscriber station detects the disturbance. These  
15   goals are achieved with the method of the invention, characterized in that a subscriber station is equipped with testing means for execution of tests indicative of the condition of the subscriber station, a predetermined testing message is transmitted via the radio path to the testing means of the subscriber station when no connection is active from the subscriber station, the testing  
20   message containing information indicating the test to be carried out, and a message indicative of the results of the test carried out is received from the subscriber station via the radio path.

          The invention is based on the idea that it is significantly easier to test the condition of a subscriber station when subscriber stations are  
25   equipped with special test units by means of which the subscriber units can independently carry out given test measurements, and transmit information indicative of the results of the test to the operator as a response to a received testing message. Consequently the operator can, whenever desirable, e.g. daily at a predetermined time of the day, start a test sequence for testing the  
30   condition of the subscriber stations in the system. The most significant advantages of the method of the invention are that it offers the operator a chance to monitor the condition of e.g. a given subscriber station without any participation of the user of said subscriber station or even any awareness that his/her subscriber station is being tested, the reliability of the system being sig-  
35   nificantly improved, and that the operator can control the testing means so that they will carry out a given test on the basis of information included in the test-

ing message, and hence all tests do not have to be carried out at the same time, but can be done periodically e.g. so that a single subscriber station will be completely tested during one week (that is, e.g. one test/day), which will shorten the time needed for testing a large number of subscriber stations.

5           The invention further relates to a system to which the method of the invention can be applied. The system of the invention is characterized in that the system comprises a subscriber station with testing means for testing the condition of the subscriber station as a response to a testing message trans-  
10       mitted from the subscriber network element via the radio path, the information in said testing message indicating to the testing means the test to be carried out, and means for transmitting a message indicative of the results of the test to the subscriber network element via the radio path, and that the subscriber network element comprises means for transmitting said testing message at a time specified by the operator, and means for receiving a message indicative  
15       of the results of the test from the subscriber station, and for forwarding the information indicative of said results to the operator. Thus the system of the invention provides the operator with a better chance than before to monitor the operation of separate subscriber stations centralized, e.g. from a network management centre.

20           In a preferred embodiment of the system of the invention, the testing means of the subscriber station comprise means for measuring the signal level of a received signal, and for transmitting a message indicative of the measuring result via the subscriber network element further to the operator. This embodiment of the invention allows the operator to receive information on  
25       the field strength as seen by the subscriber station and to conclude from this information if e.g. problems of a malfunctioning subscriber station are due to a weak field strength, i.e. the fact that the subscriber station is e.g. incorrectly placed. In this case the operator can contact the user of the subscriber station and tell him/her to transfer the subscriber station to another place where the  
30       field strength is likely to be better, or alternatively, by reconfiguration, to transfer the subscriber station to an adjacent base station. Furthermore, as the testing message and the message indicative of the results of the test are transmitted on the control channel of the system, execution of the test speeds up as no traffic channel has to be assigned to the subscriber station during the  
35       test, but all information relevant to the test can be transmitted on the control channel between the subscriber network element and the subscriber station by

utilizing system call frames.

In another preferred embodiment of the invention, signalling between a subscriber station and a subscriber network element is essentially similar to that defined in NMT-900 specifications, the subscriber network element being arranged to use frame 1a, 1a', 1a'' or 1b defined in NMT-900 specifications point 4.3.2.1 as a testing message, and the subscriber station is arranged to transfer the message indicative of the test results to the subscriber network element by frame 10a or 10d defined in NMT-900 specifications point 4.3.2.2. This embodiment of the invention provides a chance to apply the method of the invention to the WLL system based on the NMT-900 mobile communication system, the signalling of the subscriber station and the subscriber network element associated with testing a subscriber station being formed such that subscriber stations of the NMT-900 system can also be utilized in the system. This means that although all aspects of the signalling of the subscriber network element are not similar to the signalling defined in the NMT-900 specifications, the differences are, however, insignificant as regards the operation of a conventional NMT-900 mobile station, and consequently do not cause disturbance.

The invention further relates to a subscriber station for applying the method of the invention, and which can be used in the system of the invention. The subscriber station of the invention is characterized in that the terminal equipment comprises testing means for testing the condition of the subscriber station as a response to a testing message transmitted to the testing means, the information in said testing message indicating to the testing means the test to be performed, and means for transmitting a message indicative of the test results via the radio path to other parts of the system. Thus the subscriber station of the invention allows the operator to monitor its operation via the radio path without the user of the subscriber station having to participate in or be aware of the monitoring.

The preferred embodiments of the method, system and subscriber station of the invention are disclosed in the attached dependent claims 2 to 3, 5 to 7, and 9.

In the following the invention will be described in greater detail by means of a preferred embodiment of the invention with reference to the accompanying drawings, in which

Figure 1 shows a block diagram of a first preferred embodiment of

the system of the invention, and

Figures 2A and 2B illustrate signalling frames utilized in the method of the invention.

Figure 1 shows a block diagram of a first preferred embodiment of the radio system of the invention. Figure 1 shows the part of the WLL system to which the method of the invention can be applied. The WLL system shown in Figure 1 is based on the NMT-900 system (Nordisk Mobil Telefon), simplified by irrelevant properties having been omitted. Base stations 5 are similar to parts of the NMT-900 cellular radio system. This means that signalling between a subscriber station 1 and the base stations is quite similar to the signalling between a subscriber station and a base station in the NMT-900 mobile communication system. Consequently, calls to a conventional NMT-900 system mobile station 9 can also be forwarded via the base stations 5 and a subscriber network element 6, provided that the operator has programmed the subscriber network element 6 for forwarding calls regarding said telephone.

The subscriber station 1 shown in Figure 1 consists of a user interface, i.e. a telephone set 2, and terminal equipment 3. The telephone set 2 shown in Figure 1 can be a conventional voice-frequency telephone set connectable to a fixed telephone network. A two-wire line 4, via which signals can be transferred between the terminal equipment and the telephone set connects the telephone set 2 and the terminal equipment 3. The terminal equipment 3 comprises signal processing means for adapting a speech path to a radio channel. Such signal processing means include e.g. a radio part 11 comprising an antenna 8, a radio transmitter and a radio receiver, and a tele-adaptor 10 for fitting the radio part to a conventional telephone set 2.

The subscriber station 1 uses radio frequency signals to communicate via the antenna 8 with the base station 5 (the Figure shows three base stations BS) via which calls are forwarded to the subscriber network element 6 and further to an exchange 7 in a PSTN network (Public Switched Telephone Network), i.e. a fixed telephone network. In the case of Figure 1, the subscriber network element 6 can be linked to the local exchange of a fixed telephone network via e.g. an open multiplexer interface of type CCITT Q.512 V2 or V5.1 or V5.2 using a 2 Mbit/s PCM system (Pulse Code Modulation).

The subscriber network element 6 shown in Figure 1 is quite similar to the MTX exchange in the NMT-900 system except that properties irrelevant to the WLL system have been omitted, such as operations associated with

handover not needed in the WLL system.

In accordance with the invention, the terminal equipment 3 of the subscriber station 1 comprises a measuring unit 13 with means for testing the condition of the subscriber station using a plurality of optional tests. Consequently the measuring unit 13 is able to monitor the condition of the subscriber station 1 by measuring e.g. the signal level of a signal received via the radio path. The measuring unit 13 further comprises means for e.g. testing the condition of the user interface 2 by means of current, voltage and insulation resistance measurements performed on the two-wire line 4. By means of these tests the terminal equipment also finds out if a user interface 2 is at all linked to it, or if the user has unplugged the telephone from the terminal equipment 3.

The measuring unit 13 preferably also comprises a memory for recording data regarding disturbances in the operation of the terminal equipment. The data is stored in the memory until a testing message is forwarded to the subscriber station from the subscriber network element 6, leading to release of the data for the use of the operator.

In accordance with the invention, the operator may activate, e.g. from a network management centre by remote control, a test sequence in which the subscriber network element 6 goes through every system subscriber station one at a time, and performs one or more tests on them. Such a test sequence may start e.g. automatically daily at a given time. The testing time is preferably chosen so that during the testing the system loading level is low (a small number of calls in progress).

Figures 2A and 2B illustrate the signalling frames utilized in the method of the invention and in the system of Figure 1.

To test the condition of the subscriber station 1 of Figure 1, the subscriber network element 6 transmits a testing message S1 via a base station to the subscriber station 1 on a control channel. A frame 1a, 1a', 1a'' or 1b defined in the NMT-900 specifications point 4.3.2.1 (NMT Doc 900-1, January 29, 1985) is preferably used as the testing message. Figure 2A illustrates frame 1a (Calling Channel Indication, General). In accordance with this embodiment, variable Z is always assigned the value 0, whereas the test desired is denoted by values of the variables A1 to A3.

After performing the desired test, the subscriber station forwards information on the measuring result to the subscriber network element by using message S2, preferably frame 10a or 10d defined in the NMT-900 speci-



cations point 4.3.2.2. Figure 2B illustrates frame 10a (Call acknowledgement from MS on calling channel, and access on access channel). In accordance with this embodiment (and as distinct from the NMT-900 specifications) said frame is transmitted in full. The information indicative of the test results is forwarded via variables A1 to A4.

When a testing message S1, in which variable A1 has been assigned the value 1, is forwarded to the testing means 13, the measuring unit performs a test to see if a user interface is linked to the terminal equipment and if malfunction has occurred in the subscriber station. After the tests, information on the results is forwarded via the subscriber network element to the operator by message S2, i.e. by transmission of the frame of Figure 2B, variable A1 being assigned the value 1, and the bits (A2=b0b1b2b3b4b5b6b7b8, A3=b0b1b2b3b4b5b6b7b8 and A4=b0b1b2b3b4b5b6b7b8) of variables A2 to A4 being coded on the basis of the results e.g. so that in variable A2:

bit b0=1  $\Rightarrow$  user interface linked  
 bit b1=1  $\Rightarrow$  error condition 1 in terminal  
 bit b2=1  $\Rightarrow$  error condition 2 in terminal

bit b8=1  $\Rightarrow$  error condition 8 in terminal.

Similarly, when a testing message S1, i.e. the frame of Figure 2A, in which variable A1 has been assigned the value 2, is forwarded to the testing means 13, the measuring unit 13 measures the signal level of the received signal. The measuring unit 13 forwards the measurement result to the subscriber network element by message S2, where variable A1=2, and variables A2 and A3 are assigned values depicting a measured dBm value in hexadecimals (negative), that is, e.g. -91 dBm = 5B (in hexadecimals) and -112 dBm = 70 (in hexadecimals).

It will be appreciated that the above description and the accompanying drawings are presented by way of illustration only. It will be understood by those skilled in the art that various modifications and changes may be made without departing from the spirit and scope of the invention disclosed in the appended claims.

## CLAIMS

1. A method of testing the condition of a subscriber station in a radio system providing a wireless subscriber interface, **characterized** in that

5 a subscriber station (1) is equipped with testing means (13) for execution of tests indicative of the condition of the subscriber station,

a predetermined testing message (S1) is transmitted via the radio path to the testing means (13) of the subscriber station when no connection is active from the subscriber station, the testing message containing information  
10 indicating the test to be carried out, and

a message (S2) indicative of the results of the test carried out is received from the subscriber station (1) via the radio path.

2. A method as claimed in claim 1, **characterized** in that the testing means (13) comprise means for measuring the signal strength of a received signal.  
15

3. A method as claimed in claim 1, **characterized** in that the subscriber station consists of terminal equipment (3) having a radio part, and of a user interface (2) linked to the terminal equipment by means of a two-wire line (4), the testing means (13) in the terminal equipment (3) comprising  
20 means for testing of the condition of the user interface by means of current, voltage and insulation resistance measurements.

4. A radio system providing a wireless subscriber interface and comprising a subscriber network element (6) in a data transmission connection with a local exchange (7) of a public telephone network, a base station (5) and  
25 subscriber stations (1, 9), the subscriber network element (6) and said base station (5) comprising means for transfer of telecommunication signals between the local exchange and the subscriber stations, **characterized** in

that the system comprises a subscriber station (1) with testing means (13) for testing the condition of the subscriber station as a response to  
30 a testing message (S1) transmitted from the subscriber network element via the radio path, the information in said testing message indicating to the testing means (13) the test to be carried out, and means for transmitting a message (S2) indicative of the results of the test to the subscriber network element (6) via the radio path, and

35 that the subscriber network element (6) comprises means for trans-

mitting said testing message (S1) at a time specified by the operator, and means for receiving a message (S2) indicative of the results of the test from the subscriber station (1), and for forwarding the information indicative of said results to the operator.

5           5. A system as claimed in claim 4, **c h a r a c t e r i z e d** in that the testing means (13) of the subscriber station comprise means for measuring the signal level of a received signal and/or means for testing the condition of the user interface by means of current, voltage and insulation resistance measurements performed on the two-wire line (4).

10           6. A system as claimed in claim 4, **c h a r a c t e r i z e d** in that the subscriber network element (6) is arranged to transmit the testing message (S1) to the subscriber station on a system control channel, and that the subscriber station (1) is arranged to forward said message (S2) indicative of the results of the test to the subscriber network element (6) on a control channel.

15           7. A system as claimed in claim 4, **c h a r a c t e r i z e d** in that signalling between a subscriber station (1) and a subscriber network element (6) is essentially similar to that defined in NMT-900 specifications, the subscriber network element being arranged to use frame 1a, 1a', 1a'' or 1b defined in NMT-900 specifications point 4.3.2.1 as a testing message (S1), and the subscriber station (1) is arranged to transfer the message (S2) indicative of the test results to the subscriber network element (6) by frame 10a or 10d defined in NMT-900 specifications point 4.3.2.2.

20           8. A subscriber station (1) in a radio system providing a wireless subscriber interface and consisting of terminal equipment (3) with a radio part (8, 11), and of a user interface (2) linked to the terminal equipment (3) by means of a two-wire line (4), **c h a r a c t e r i z e d** in that the terminal equipment (3) comprises

30           testing means (13) for testing of the condition of the subscriber station (1) as a response to a testing message (S1) transmitted to the subscriber station via the radio path, the information in said testing message (S1) indicating the test to be carried out, and

          means (8, 11) for transmitting a message (S2) indicative of the test results via the radio path to other parts (5, 6) of the system.

35           9. A subscriber station as claimed in claim 8, **c h a r a c t e r i z e d** in that the testing means (13) comprise means for measuring the signal level of a received signal and/or means for testing the condition of a user interface

(2) by means of current, voltage and insulation resistance measurements performed on the two-wire line (4).

1/2

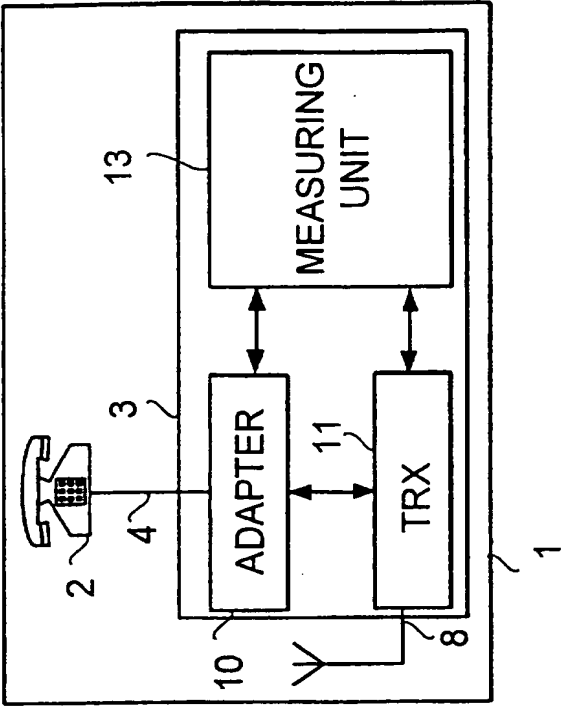
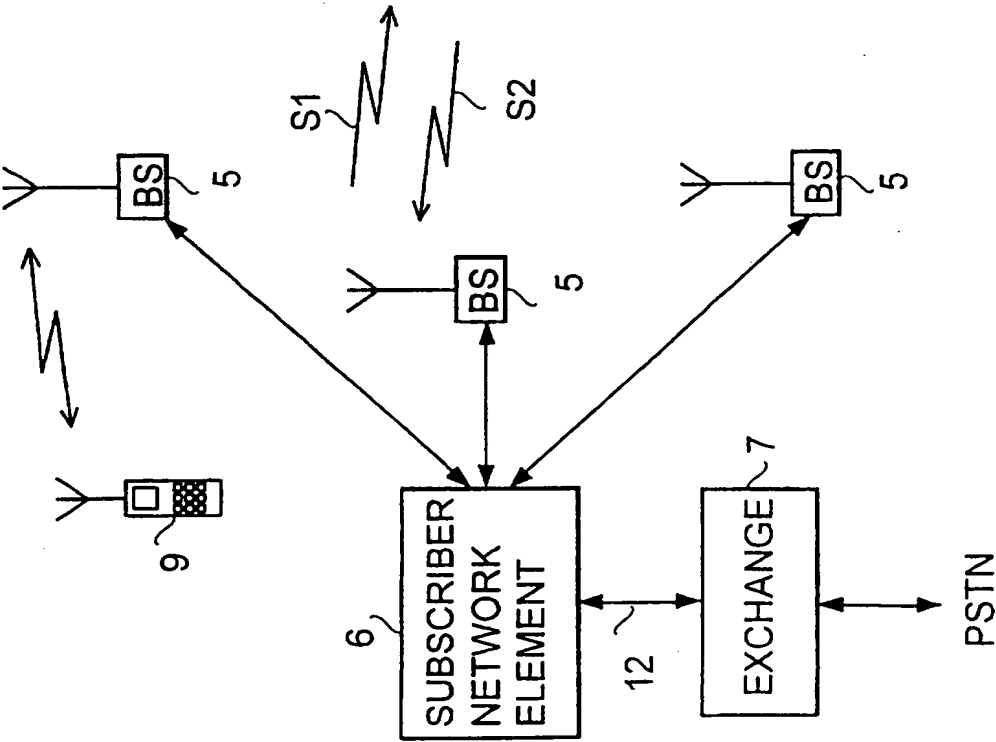


FIG.1



CHANNEL NO.	PREFIX	TA NO	MOBILE SUBSCRIBER NO	INFORMATION
N1N2N3	P(12)	Y1Y2	ZX1X2X3X4X5X6	A1A2A3

FIG. 2A

CHANNEL NO.	PREFIX	MOBILE SUBSCRIBER NO	AREA INFO	IDLE
N1N2N3	P(1)	ZX1X2X3X4X5X6	T	A1A2A3A4

FIG. 2B

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 97/00151

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/34, H04M 3/30, H04B 17/00, H04B 7/24 // H04B 3/46  
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## B. FIELDS SEARCHED

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EPAT, NPL, JAPIO

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0543161 A2 (SGS-THOMSON MICROELECTRONICS S.R.L.), 26 May 1993 (26.05.93), column 1, line 1 - column 3, line 10 --	1-9
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## INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/07/97

International application No.

PCT/FI 97/00151

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